

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of: Agarwala et al.

Docket No.: BUR920000215US1

Serial No.: 09/871,883

Group Art Unit: 2815

Filed: June 1, 2001

Examiner: Warren, Matthew E.

Title: DUAL-DAMASCENE METALLIZATION INTERCONNECTION (As Amended)

Commissioner for Patents  
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REPLY BRIEF OF APPELLANTS

This Reply Brief addresses issues raised in the Examiner's Answer mailed September 2003.

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Issue 1

**CLAIMS 1-4, 6-13, 15-20, 22-25, 27-29 ARE NOT UNPATENTABLE UNDER 35 U.S.C. §103(A) OVER FARRAR (US 6,376,370 B1) IN VIEW OF Havemann (US 6,156,651).**

The Examiner rejected claims 1-4, 6-13, 15-20, 22-25, 27-29 under 35 U.S.C. §103(a) as allegedly unpatentable over Farrar (US 6,376,370 B1) in view of Havemann (US 6,156,651).

Claim 1

The Examiner's Answer alleged that Havemann discloses the following feature of claim 1: "at least a portion of the bottom of said upper level wire extending below a top surface of said lower wire level". Havemann shows (fig. 3G) an interconnect structure in which a lower level



has a lower core conductor (39) and a lower conductive liner (36). An upper level wire has an upper core conductor (52) and an upper liner (48), in which the upper liner is in contact with the lower liner to form a liner-to-liner contact region. A portion of the bottom of the upper level wire extends below a top surface of the lower wire level”.

Appellants contend that the preceding argument by the Examiner in the Examiner’s is invalid, since Havemann does not teach or suggest that the upper liner 48 is conductive as required by claim 1. In particular, Havemann teaches that the liner 48 is made of silicon nitride which is insulative and thus non-conductive.

With respect to the conductive aspect of the upper liner 48, the Examiner’s Answer argues: “The applicant argues that the upper liner (48) of Havemann cannot be conductive because it is listed as a silicon nitride (col. 4, lines 65-67). The examiner believes that the liner (48) may be conductive because the purpose of forming the upper level is to be a conductor groove (col. 4, lines 55-64). If the groove is to be conductive then everything within it must be conductive including the liner (48) and the core (52). Furthermore, Havemann calls liner (48) an encapsulation layer in the same way lower liner (36) is labeled a via encapsulation layer (col. 4, lines 37-40) having titanium nitride, which is known to be conductive. It seems that if liner layer (48) is non-conductive, then the via which it forms cannot make electrical contact with the lower via. Although silicon nitride is listed only as an example of the upper liner layer (48) there is nothing else in the text of Havemann to indicate that the layer is non-conductive. Therefore, it is assumed that upper liner layer is conductive and forms the appropriate liner-to-liner contact region as stated in the claims.”.

In reply to the preceding argument by the Examiner, Appellant notes that the Examiner’s

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Answer has made the following logically inconsistent argument: “If the groove is to be conductive then everything within it **must** be conductive including the liner (48) and the core (52)” (emphasis added). Thus, Appellant contends that if the upper liner 48 **must** be conductive then Havemann would not disclose that the upper liner 48 is made of non-conductive silicon nitride. Additionally, Havemann does not teach or suggest anywhere that the upper liner 48 could be conductive. Thus, the Examiner’s assumption that the upper liner 48 is conductive cannot be reasonably supported. It therefore follows that the Examiner’s argument that Havemann discloses the feature “at least a portion of the bottom of said upper level wire extending below a top surface of said lower wire level” is defective, because the Examiner argues that the upper liner 48 comprises the portion of the bottom of the upper level wire that extends below a top surface of the lower wire level as required by claim 1, and claim 1 requires said upper level wire to be conductive. Accordingly, Appellant maintains that the Examiner has not established a *prima facie* case of obviousness in relation to claim 1.

The Examiner’s Answer makes the following additional argument: “Even if the upper liner (48) of Havemann were non-conductive, Farrar already discloses an upper liner of conductive material. One would only look to Havemann to obtain the structure of the liner-to-liner contact region or a portion of the upper level conductor extending below a top surface of the lower level conductor.” In response, Appellant contends that the preceding additional argument is invalid, because the preceding argument (i.e., that Havemann discloses the requirement in claim 1 of a liner-to-liner contact and the condition of the bottom of the upper wire extending below a top surface of the lower liner) depends on the upper liner 48 being comprised by the upper level wire of claim 1 as an upper conductive liner. However, the upper

liner 48 cannot be comprised by the upper level wire as an upper conductive wire as explained *supra* by Appellant, and as assumed in the Examiner's Answer for the purpose of said additional argument.

Appellant further contends that the Examiner's additional argument is a new ground of rejection and therefore cannot be used against Appellant in the present Appeal.

Accordingly, Appellant contends that claim 1 is not unpatentable over Farrar in view of Havemann, and the rejection of claim 1 should therefore be reversed.

Also with respect to claim 1, the Examiner's Answer alleged that it is obvious "to modify the liner-to-liner contact region of Farrar with the second and third coextensive regions taught by Havemann to form a contact without mechanical defects", based on the following statement in the Havemann Abstract: "Methods are shown for realizing desirable insulating and conducting layers without deleterious mechanical effects".

In reply to the preceding allegation by the Examiner's Answer, Appellant asserts that the preceding citation from the Havemann Abstract does not support the contention in the Examiner's Answer that it obvious to modify Farrar with Havemann "to modify the liner-to-liner contact region of Farrar with the second and third coextensive regions taught by Havemann to form a contact without mechanical defects".

As a first reason why it is not obvious to modify Farrar with Havemann based on the citation in the Havemann Abstract, the Examiner's Answer has distorted the word "effects" in the Havemann Abstract to erroneously mean "defects" for the purpose of interpreting Havemann. Based on the Havemann Abstract, the Examiner's Answer developed an argument for combining

Havemann with Farrar on the assumption that Havemann teaches forming a contact “without mechanical defects” (emphasis added). Appellant contends, however, that Havemann does not disclose anywhere the forming of a contact “without mechanical defects” as alleged by the Examiner. The Havemann Abstract referred to by the Examiner specifically recites: “Methods are shown for realizing desirable insulating and conducting layers without deleterious mechanical effects” (emphasis added). The Examiner has incorrectly concluded that a “defect” is equivalent to an “effect”. Appellant maintains that a “defect” is “a fault or imperfection”. *The Random House Common Dictionary* 348 (revised ed. 1988). Appellant further maintains that an “effect” is “something that is produced by an agency or cause; result; consequence”. *Id.* at 420. Therefore, the Examiner’s argument for combining Havemann with Farrar, being based on an incorrect assumption as to what Havemann teaches, has no persuasive weight.

As a second reason why it is not obvious to modify Farrar with Havemann based on the citation in the Havemann Abstract, the Havemann disclosure does not provide any information as to what aspects of the Havemann methodology are responsible for realizing insulating and conducting layers without deleterious mechanical effects. Without this information one of ordinary skill in the art has no way of knowing which aspects of the Havemann methodology to import into Farrar in order to realize insulating and conducting layers without deleterious mechanical effects.

As a third reason why it is not obvious to modify Farrar with Havemann based on the citation in the Havemann Abstract, the Examiner has not identified anything in the Farrar disclosure that indicates that Farrar discloses forming insulating and conducting layers with deleterious mechanical effects. In other words, the only scenario making it obvious to modify

Farrar with Havemann is a scenario in which Farrar is problematic due to forming insulating and conducting layers with deleterious mechanical effects, so that modifying Farrar with Havemann would improve the Farrar methodology. However, the Examiner has not only not produced evidence that Farrar is problematic in that manner, but the Examiner has not even considered the issue of whether Farrar is problematic in that manner. In other words, Appellant contends that it is not obvious to modify Farrar with Havemann to solve a non-existent problem in Farrar or to improve Farrar when no evidence has been produced to show that Farrar will be improved.

Accordingly, Appellant contends that it is not be obvious to combine Farrar with Havemann, and the rejection of claim 1 should therefore be reversed.

#### Claims 7-8

With respect to claims 7-8, Appellants contend that Farrar in view of Havemann does not teach or suggest the following feature of claims 7-8: “wherein said liner-to liner contact region further comprises a second portion co-extensive with said lower conductive liner on a portion of a second side of said lower level wire under said upper level wire” (claim 7); and “wherein said liner-to-liner contact region further comprises a third portion co-extensive with said lower conductive liner on an end of said lower level wire under said upper level wire” (claim 8).

The Examiner’s Answer alleges that Havemann teaches: “An upper level wire has an upper core conductor (52) and an upper liner (48), in which the upper liner is in contact with the lower liner to form a liner-to-liner contact region.... The liner-to-liner contact region also comprises a second portion (overlap portion of liner 48) co-extensive with the lower liner on a portion of a second side (outer portion of liner 36) of the lower level wire and a third portion

(overlap portion of liner 48 in the hole) co-extensive with the lower conductive liner on an end (inner portion of the liner 36) of the lower level wire, each portion being under the upper level wire.”

Thus the Examiner’s Answer argues that the layer 48 is the upper conductive layer that forms part of the liner-to-liner contact region. Appellant contends, however, that Havemann does not disclose that layer 48 is conductive. To the contrary, Havemann discloses that layer 48 comprises silicon nitride (see Havemann, col. 4, lines 65-67). Since silicon nitride is electrically insulative, the layer 48 cannot qualify as the upper conductive layer. Accordingly, the Examiner’s argument for rejecting claims 7-8 is erroneous, and the rejection of claims 7-8 under 35 U.S.C. §103(a) should accordingly be reversed.

Claims 10, 16-18, 20, 23-24, 25, and 28-29

Appellant note that the Examiner’s Answer has not rebutted arguments appearing in Appellant’s Appeal Brief relating to claims 10, 16-18, 20, 23-24, 25, and 28-29.

Issue 2

**CLAIMS 30-33 ARE NOT UNPATENTABLE UNDER 35 U.S.C. §103(A) OVER FARRAR (US 6,376,370 B1) IN VIEW OF OTSUKA ET AL. (US 6,1373, 136 B2).**

The Examiner rejected claims 30-33 under 35 U.S.C. §103(a) as allegedly unpatentable over Farrar (US 6,376,370 B1) in view of Otsuka et al. (US 6,1373, 136 B2).

### Claims 30 and 31

The Examiner's Answer alleged that "Otsuka et al. discloses (col. 12, lines 30-52) insulating pillars formed in a level of wiring. With such a configuration a highly reliable damascene structure is formed (col. 2, lines 50-52)." In response, Appellant contends that the preceding allegation by the Examiner's Answer is not persuasive, because the preceding allegation in the Examiner's Answer is not an argument that Farrar in view of Otsuka discloses the following feature of claims 30 and 31: "said lower conductive liner on sides of said dielectric pillars". Thus, Appellant contends that the Examiner has not established a *prima facie* case of obviousness in relation to claims 30 and 31, and the rejection of claims 30 and 31 should accordingly be reversed.

Additionally with respect to claims 30 and 31, the Examiner's Answer argues: "Otsuka et al. discloses (col. 12, lines 30-52) insulating pillars formed in a level of wiring. With such a configuration a highly reliable damascene structure is formed (col. 2, lines 50-52). Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the lower interconnect wiring level of Farrar by adding dielectric pillars as taught by Otsuka et al. to form a highly reliable damascene wiring structure."

In reply, Appellant contends that the improved reliability against void formation taught by Otsuka is not required in Farrar because Farrar already utilizes a different method of improved reliability against void formation. Otsuka teaches in col 3, lines 37 to 43: "With these structures described above, a diameter of crystal grains in the upper wiring above the via hole becomes small so stress migration can be suppressed and wiring disconnections can be reduced. Wiring defects to be caused by stress migration can be suppressed even if a wide wire is formed by using



the dual damascene process.” Appellant points out that layers 323, 383, 384 of Farrar already mitigate against stress migration by surrounding the core conductors (copper) with metals not subject to stress migration (tantalum, and tantalum nitride) thus maintaining electrical contact even if voids form in the core conductor. Therefore, there is no need to apply the solution of Otsuka to a problem already solved by Farrar. Accordingly, Appellant contends that the Examiner has not established a *prima facie* case of obviousness in relation to claims 30-31, and the rejection of claims 30-31 should accordingly be reversed.

Indeed, Appellant contends that formation of dielectric pillars in Farrar’s structure would add an unnecessary expense that Farrar specifically teaches to avoid in col. 2. lines 37 to 42 by stating “If however the lines are made wider, fewer wiring channels can be provided in each metal level. To obtain the same number of wiring channels, additional levels of metal must be provided. This increases the chip cost. So if this approach is to be followed, it is imperative that a low cost process be adopted.” and in col. 4, lines 61 to 62 further stating “What is disclosed herein is a low cost process to achieve reduced capacitance and resistance loss in wiring levels.” Appellant contends that addition of the dielectric pillars of Otsuka to Farrar are not necessary and add an un-necessary expense to the fabrication of Farrar’s structure. Accordingly, Appellant contends that the Examiner has not established a *prima facie* case of obviousness in relation to claims 30 and 31, and the rejection of claims 30 and 31 should accordingly be reversed.

Based on the any of the preceding arguments, Appellant contends that claims 30 and 31 are not unpatentable over Farrar in view of Otsuka and the rejection of claims 30 and 31 under 35 U.S.C. §103(a) should accordingly be reversed.

### Claims 32 and 33

Appellant note that the Examiner's Answer has not rebutted arguments appearing in Appellant's Appeal Brief relating to claims 32 and 33.

### Issue 3

**CLAIMS 34 AND 35 ARE NOT UNPATENTABLE UNDER 35 U.S.C. §103(A) OVER FARRAR ET AL. (US 6,376,370 B1) IN VIEW OF OTSUKA ET AL. (US 6,1373, 136 B2) AND IN FURTHER VIEW OF HAVEMANN (US 6,156,651).**

The Examiner rejected claims 34 and 35 under 35 U.S.C. §103(a) as allegedly unpatentable over Farrar et al. (US 6,376,370 B1) in view of Otsuka et al. (US 6,1373, 136 B2) and in further view of Havemann (US 6,156,651).

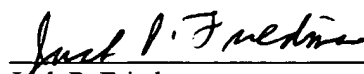
### Claims 34 and 35

Appellant note that the Examiner's Answer has not rebutted arguments appearing in Appellant's Appeal Brief relating to claims 34 and 35.

## SUMMARY

In summary, Appellants respectfully request reversal of the 35 U.S.C. §103(a) rejection of claims 1-4, 6-13, 15-20, 22-25 and 27-35.

Respectfully submitted,

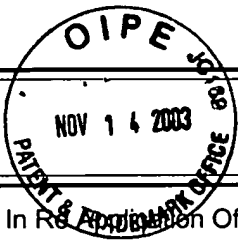


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Serial No.	Filing Date	Examiner	Group Art Unit
09/871,883	6/1/2001	Warren, Matthew E.	2815 ✓

Title: **DUAL-DAMASCENE MULTI-LEVEL METALLIZATION**

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